University of California, Berkeley
Physics 110B Spring 2001 Section 1 (*Strovink*)

Problem Set 2

1. Griffiths 9.21.

2. Griffiths 9.22.

3. Griffiths 9.23.

4. Griffiths 9.24.

5. Griffiths 9.38. Consider the TE modes only.

6. Griffiths 9.31 part (b) only.

7. Show that the characteristic impedance $Z_0 \equiv \Delta V/I$ of the coaxial cable in the previous problem is

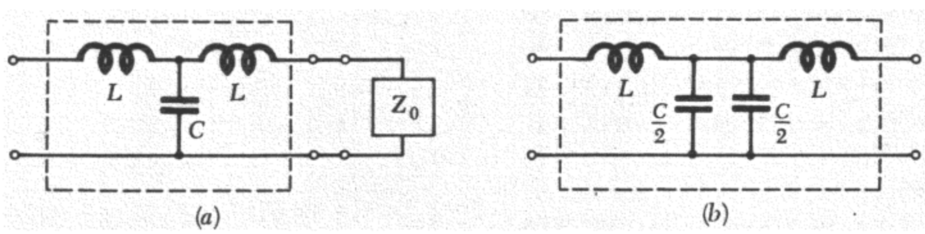
$$Z_0 = \frac{1}{2\pi}\sqrt{\frac{\mu}{\epsilon}}\ln\frac{b}{a}$$

and that this result is equivalent to

$$Z_0 = \sqrt{\frac{L'}{C'}}$$

where L' and C' are the cable's inductance and capacitance per unit length, respectively.

8. In the circuit (a), an impedance Z_0 is to be connected to the terminals on the right.
(**a**) For given frequency ω, find the value that Z_0 must have if the resulting impedance between the left terminals is also to be Z_0. You should find that the required Z_0 is a (frequency-dependent) *pure resistance* R provided that $\omega^2 < 2/LC$.



(**b**) A chain of such boxes can be connected together to form a so-called ladder network. If the chain is terminated with a resistor of the correct (frequency-dependent) value R, show that its input impedance at frequency $\omega < \sqrt{2/LC}$ will continue to be R, regardless of the number of boxes that are added to the chain. (This type of ladder circuit is called a *lumped-element delay line*. In the low-frequency limit, the delay line's characteristic impedance reduces to

$$Z_0 \rightarrow \sqrt{\frac{L'}{C'}}\ ,$$

where $L' \propto 2L$ is the inductance per unit length, and $C' \propto C$ is the capacitance per unit length.)
(**c**) What is Z_0 in the special case $\omega = \sqrt{2/LC}$? (You may find it helpful to note that the contents of the box (a) are equivalent to those of the box (b).)